Nonlinear Spectral Dynamics and Energization of Space Plasmas by Kinetic Alfvén Waves

M. Goossens et al.
CPA, K.U.Leuven, Belgium

Classic Alfvén waves (AWs) can be converted into kinetic Alfvén waves (KAWs) by phase mixing in inhomogeneous space plasmas, such as solar corona, solar wind and other astrophysical objects. Linear phase mixing on its own appears not to be able to provoke significant kinetic effects in AWs propagating initially along magnetic field. Here we present mechanisms that are more efficient once phase mixing has created the perpendicular wavenumber in a small-amplitude AW. In the framework of two-fluid MHD we show that the initial AW can nonlinearly couple its energy to other, secondary AWs, resulting in nonlinear spectral transfer of wave energy. The nonlinear generation of secondary waves can initiate a turbulent cascade of energy towards smaller scales and higher frequencies, where kinetic dissipation mechanisms of KAWs due to Landau and cyclotron damping are of a prime importance.

The recent SOHO observations of the solar corona and solar wind, implying dissipation of small-scale and/or high-frequency Alfvén waves, are discussed in the light of our theoretical results. We suggest that the spectral dynamics and consequent dissipation of KAWs introduced by the combined action of phase mixing and nonlinear interaction is a widespread phenomenon, important for astrophysical plasmas.

Co-author: *Yu. Voitenko (MAO, Kyiv, Ukraine)*